Peculiarities of hydrogen interaction with Ni powders and melt spun $Nd_{90}Fe_{10}$ alloy

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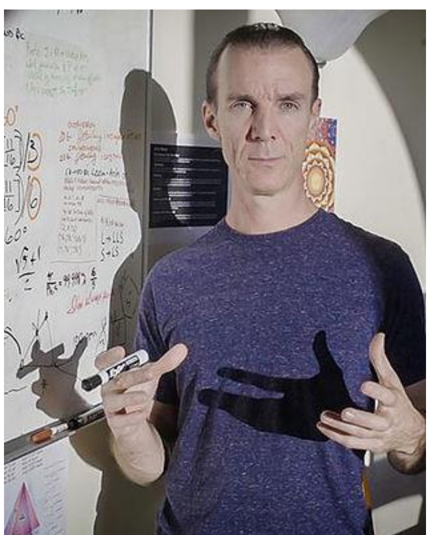


GRAVITY
RESEARCH
QUANTUM
QGR

Russ Gries

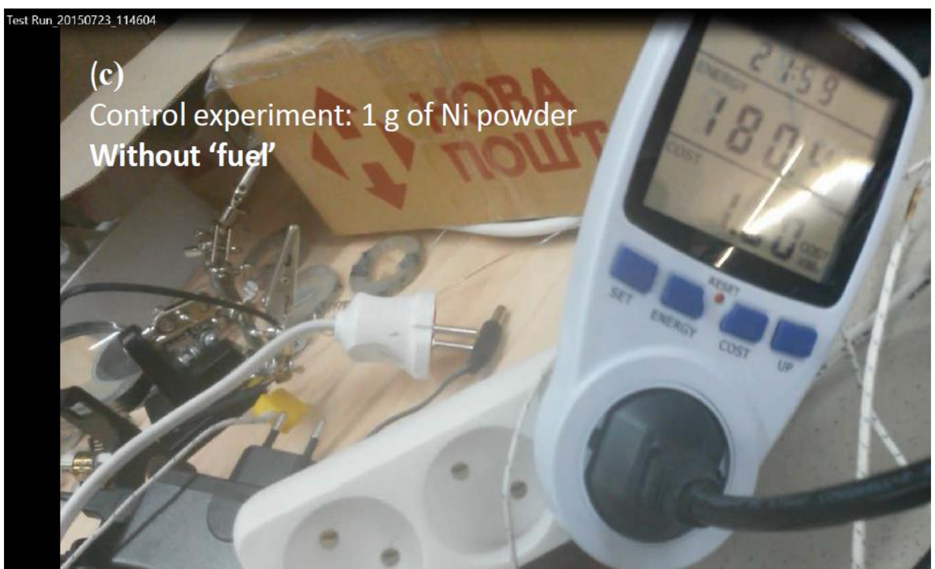
MOTIVATION

Hydrogen interaction with Ni powders has provoked a lot of excitement and controversy due to the works of Rossi, Parkhomov and others, who claimed to produce excess heat in their experiments that could not be explained by conventional chemical reactions. Yet, there is no reliable 100% evidence of the effect up to date, and some of subsequent experiments produced less or *zero* effect as their measuring accuracy increased. Unfortunately, the claimed evidence often depends on indirect calorimetry methods and as such it does not produce an ultimate proof. We present an experimental setup that allows accurate measuring of the main parameters controlling the reaction: **hydrogen pressure, temperature inside the fuel and at the heater**, the difference between which can provide direct evidence of the excess heat.

Our program pursues two goals: (i) verify the previous results and (ii) test our facility in a wide range of parameters to be used in experiments with novel types of fuel that we plan to create in future.

PREHISTORY

SUCCESSFUL replication of LENR performed by Nick Oseyko (2015)



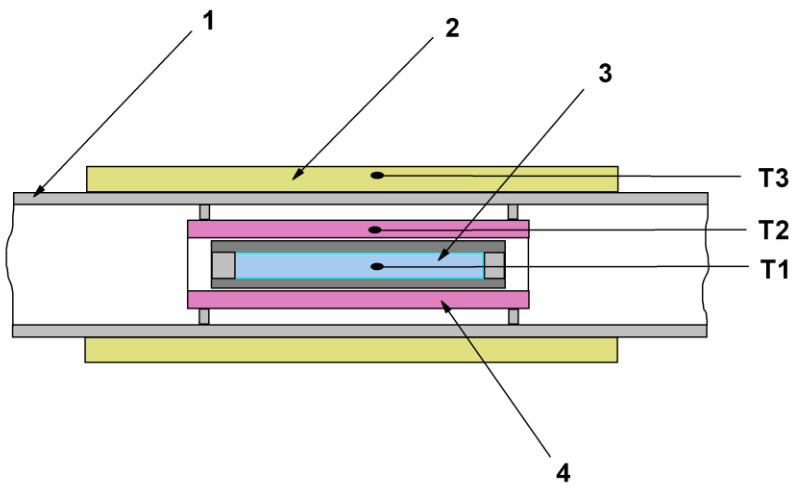
UNSUCCESSFUL replication of LENR performed by Nick Oseyko (2016)

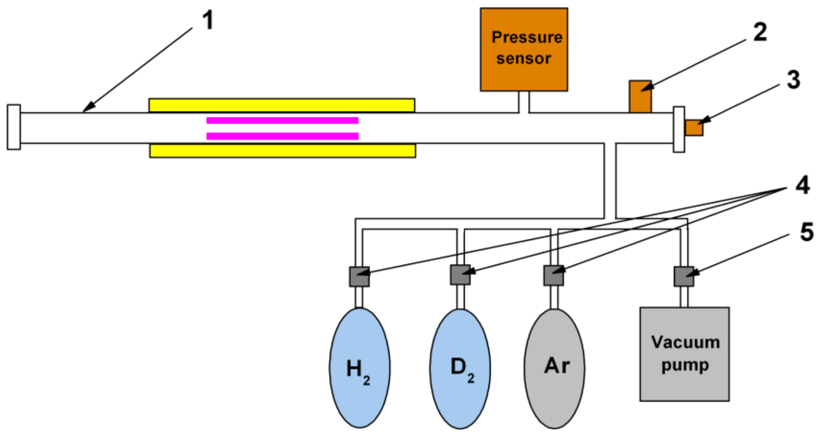
Outline of the present experiments

- Interaction of Ni with H and $LiAlH_4$ under heating and gamma irradiation

- Interaction of melt spun amorphous alloy $Nd_{90}Fe_{10}$ with H/D under heating and gamma irradiation

Schematic picture of the reactor system





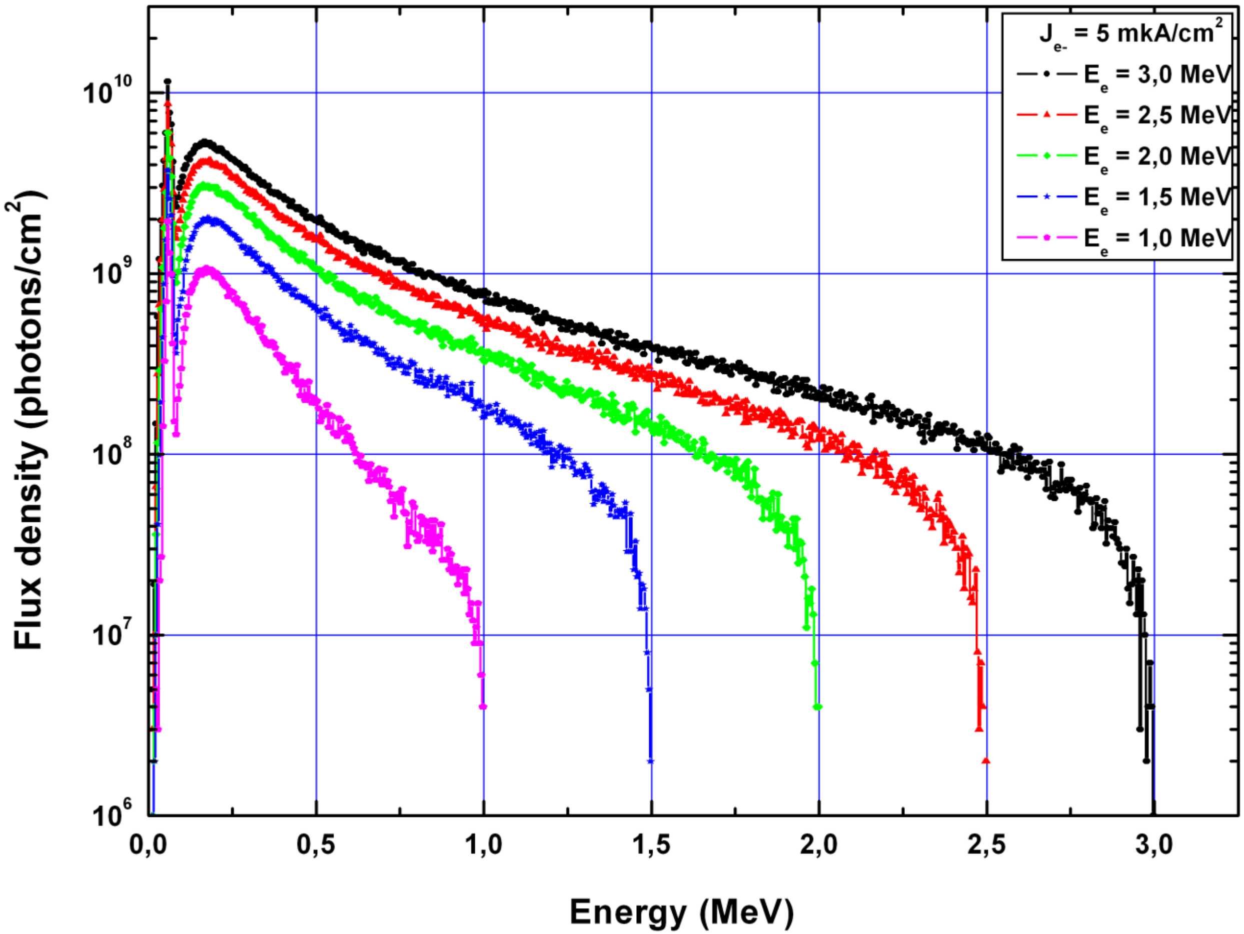
Ceramic tube (1); heat-insulation (2); experimental ‘fuel’ (3); ceramic tube with a heater (4).

Ceramic tube (1); with electric current inputs for the heater (2); flange for entering the thermocouples T1 and T2 (3) gas valves (4); vacuum valve (5)

Photo of the reactor system

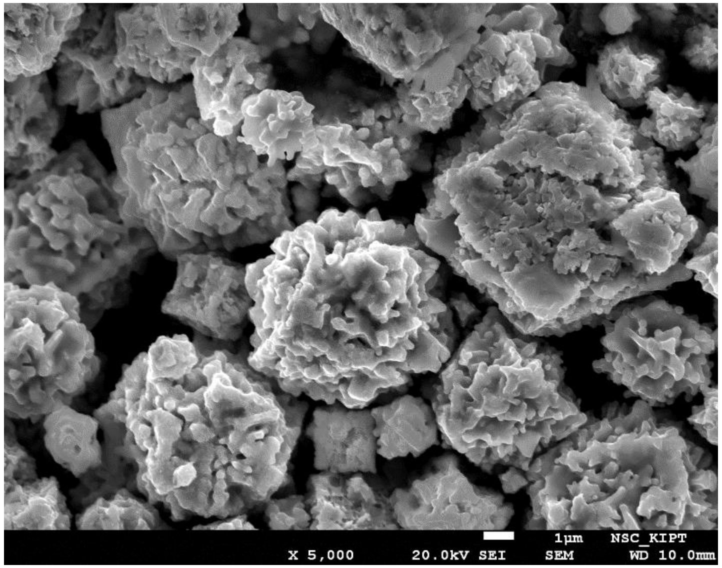
Electron accelerator ELIAS at the NCS KIPT

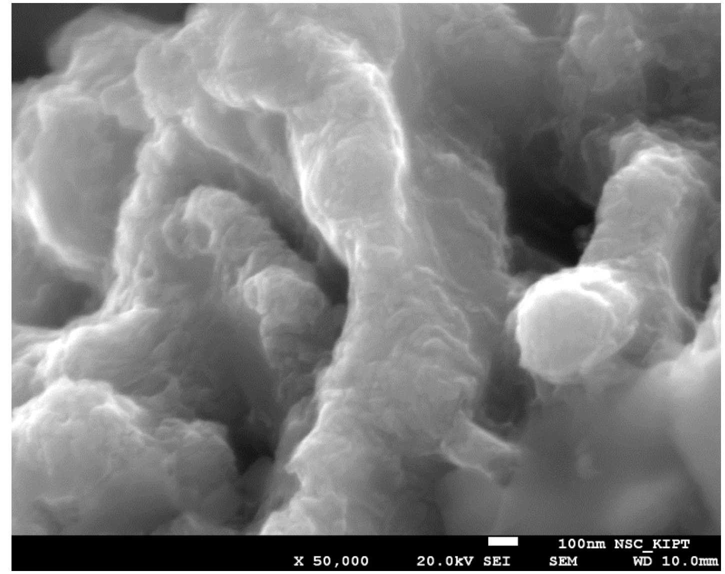
γ-irradiation of the sample



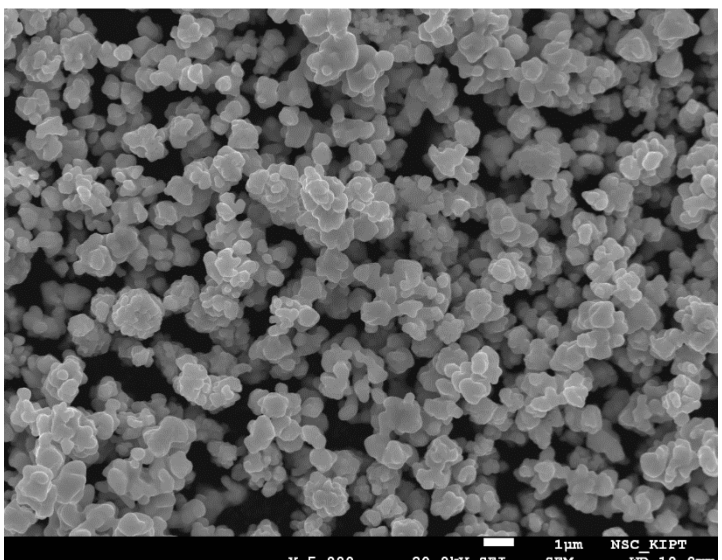
The spectra of bremsstrahlung γ-quanta after the tantalum convertor under its irradiation by electron beams of different energies

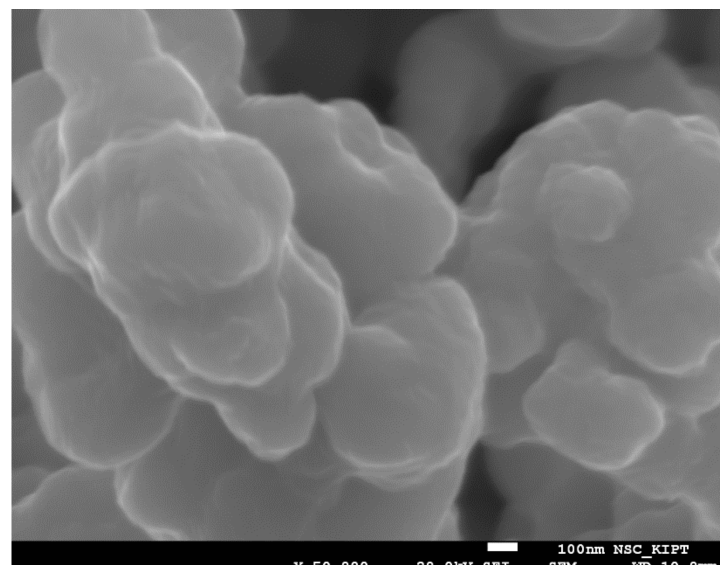
SEM of the Nickel_Oseyko, Kiev



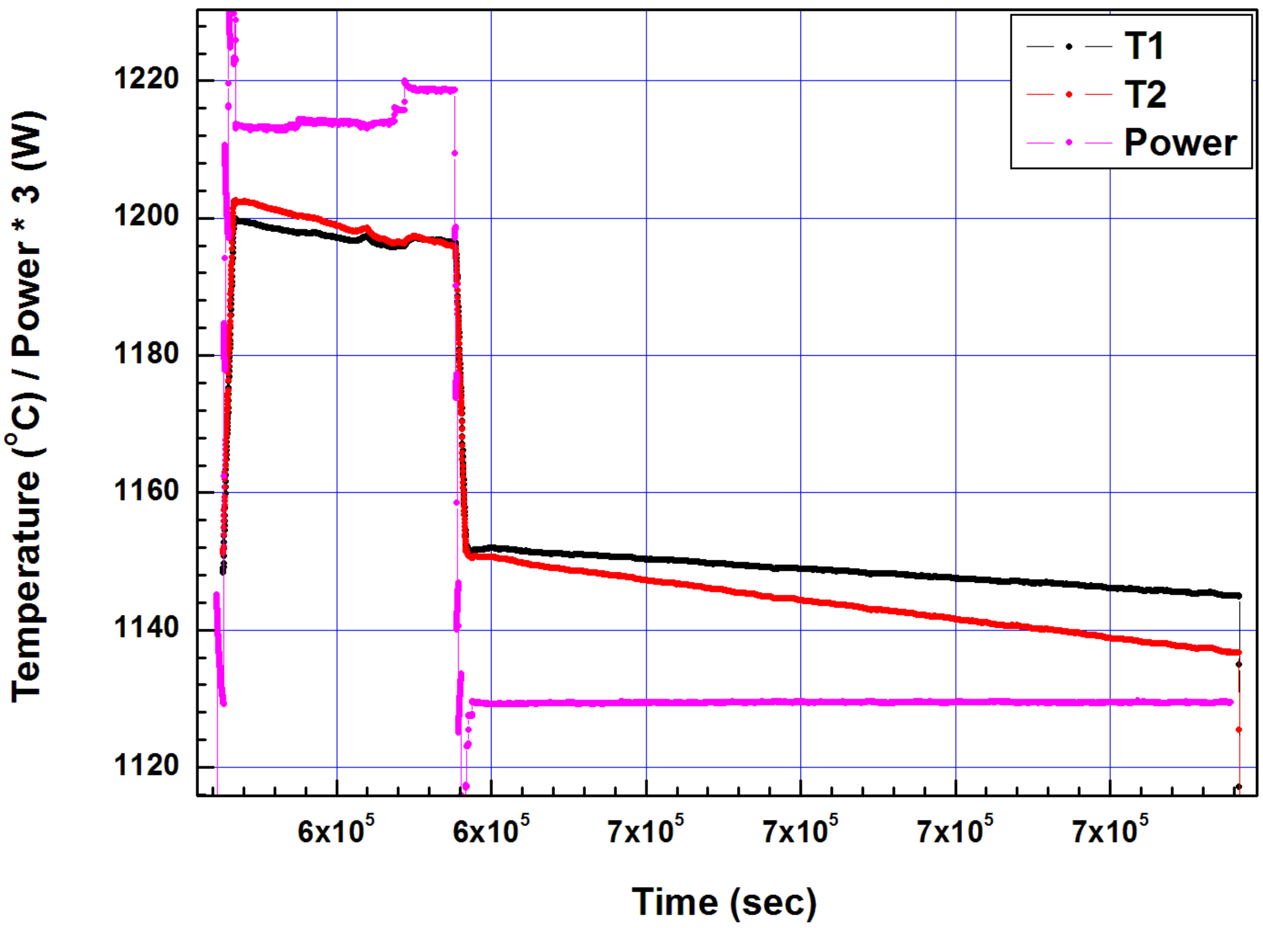


SEM of the Nickel_Archer, UK



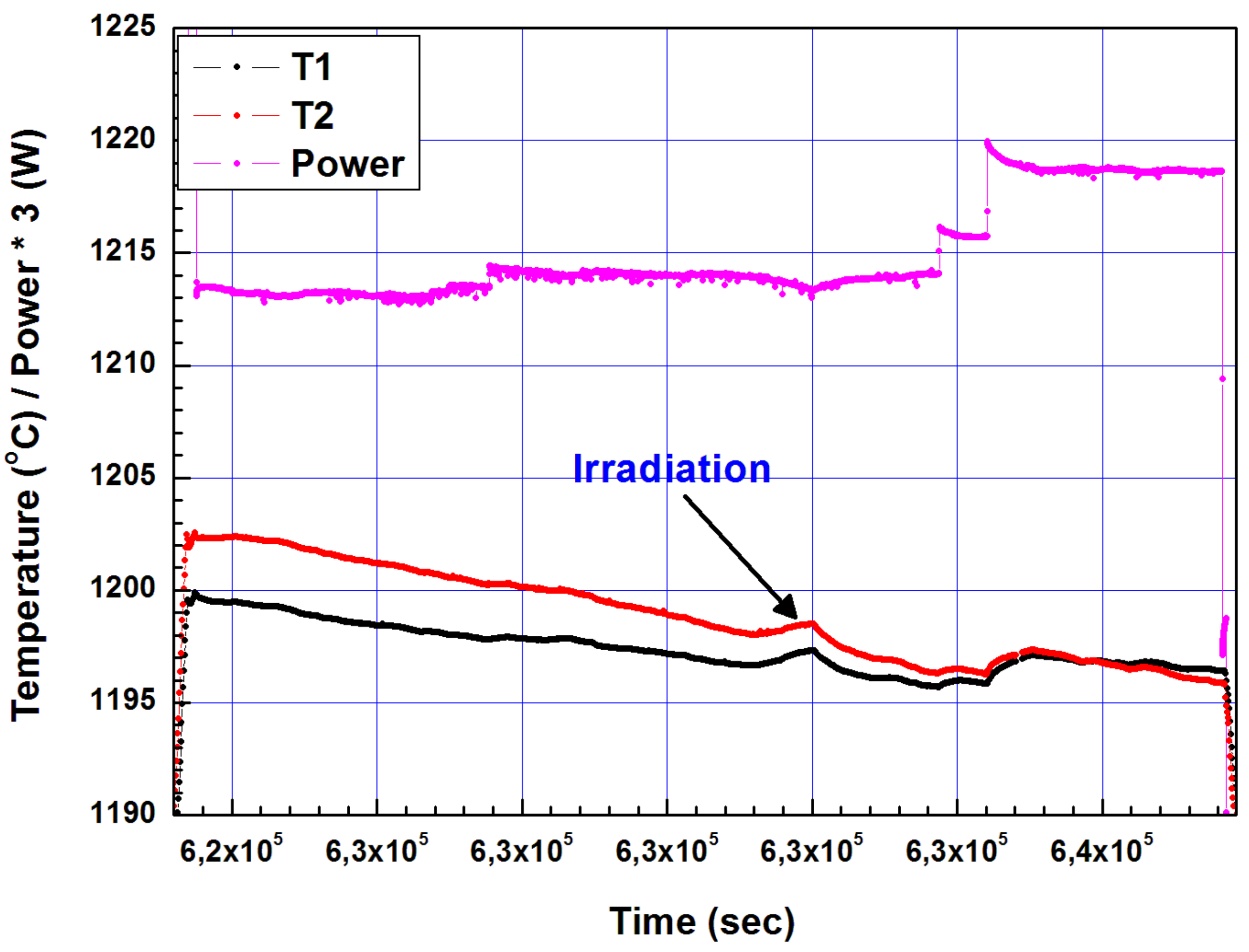


Interaction of Ni_Oseyko with H



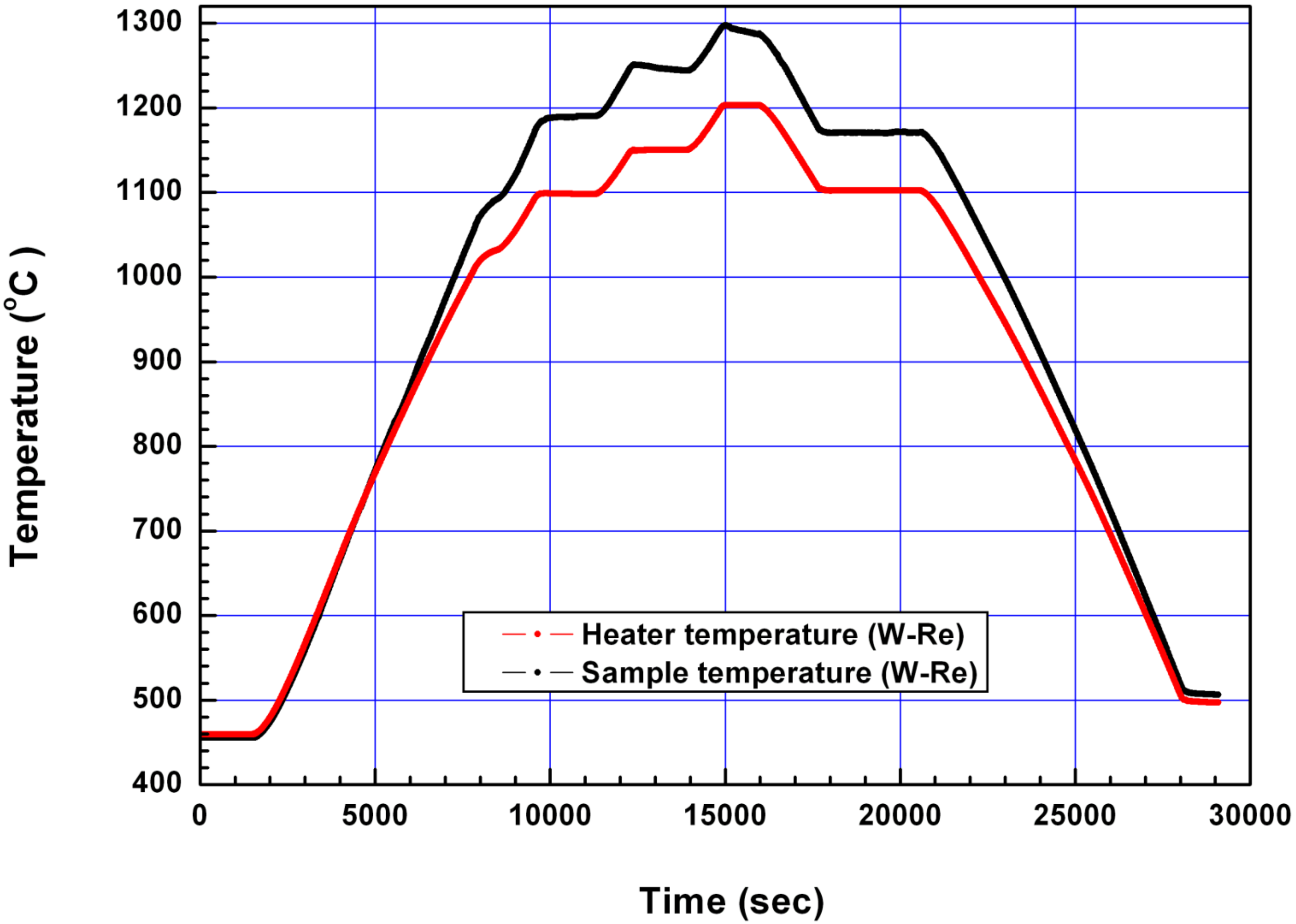
The time dependence of the temperatures of the sample (T1) and the heater (T2) as well as the input power to the heater (the seventh day of the experiment)

Irradiation of the bremsstrahlung γ-quantum flux with a continuous energy spectrum, received on a tantalum convertor using an electron beam with the current of 160 μA and the energy of 2.5 MeV



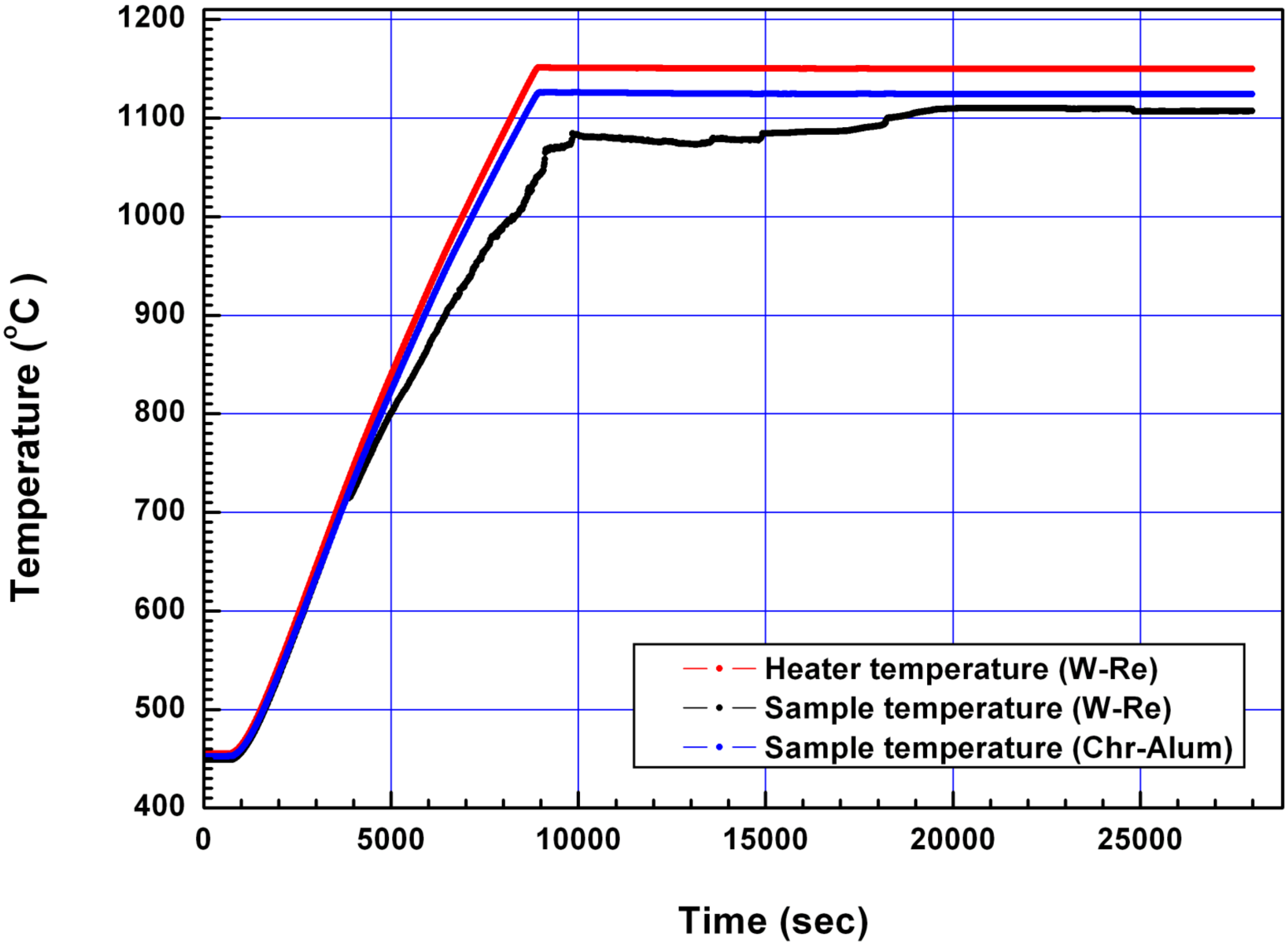
The first experiment with Nickel_Oseyko and $LiAlH_4$. (02-05-2017)

Excess heat ~1 MJ ???



The second experiment with Nickel_Oseyko and $LiAlH_4$. (19-05-2017)

Artefact due to the W-Re thermocouple degradation ???



DISCUSSION

It looks like the interaction of W-Re thermocouple with $LiAlH_4$ resulted in a degradation of the thermocouple, which started showing either higher or lower temperatures than the real T, with unpredictable outcome. Why it responds differently to the same environment, is unclear at the moment.

In his abstract for the conference, Daniel Szumski claims that

"both endo-thermal and exo-thermal nuclear reactions occur, and that it is the predominance of one over the other that produces excess heat or no excess heat. It is only the sign of the heat change that is random."

However, in our case the second thermocouple did not show any response to the reaction, indicating an artefact

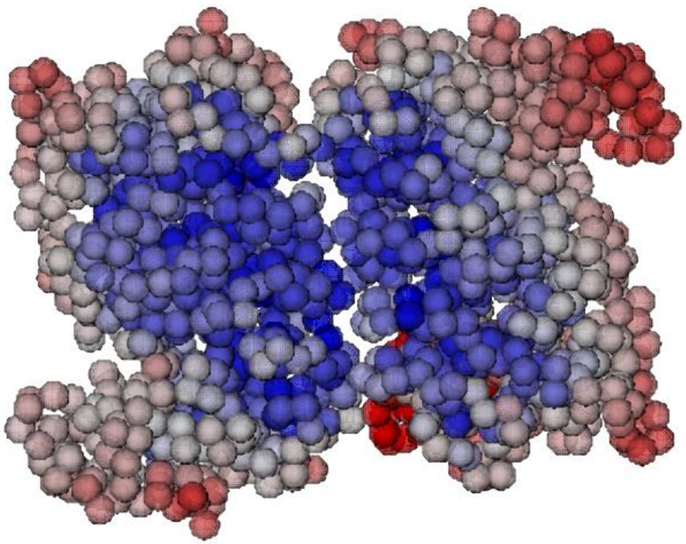
Interaction of melt spun $Nd_{90}Fe_{10}$ with H_2 and D_2

Motivation

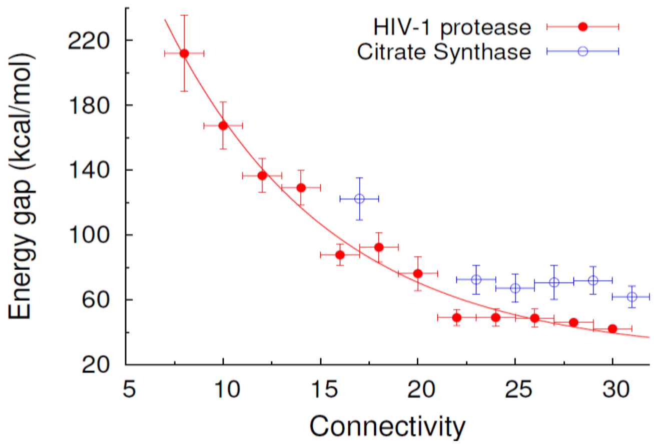
Chemical and Nuclear catalysis

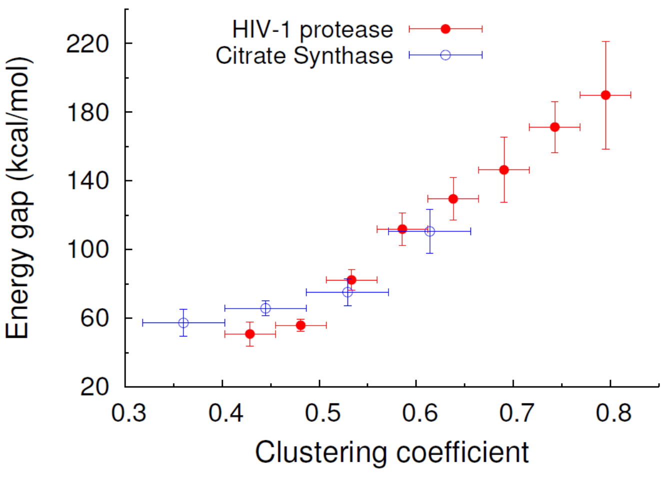
the role of disorder in the LAV creation

"Cracks and small particles are the Yin and Yang of the cold fusion environment" E. Storms



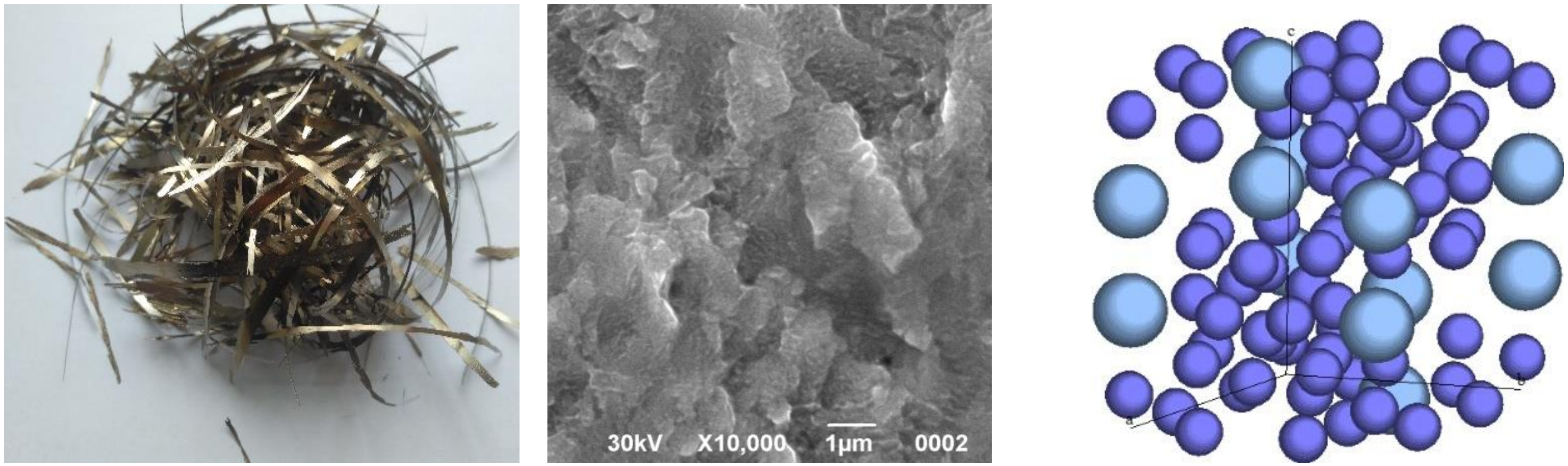
Structure of dimeric citrate synthase (PDB code 1IXE). Only α-carbons are shown, as spheres in a color scale corresponding to the crystallographic B-factors, from smaller (blue) to larger (red) fluctuations [Dubinko, Piazza, 2014]





Creation of nonequilibrium structures

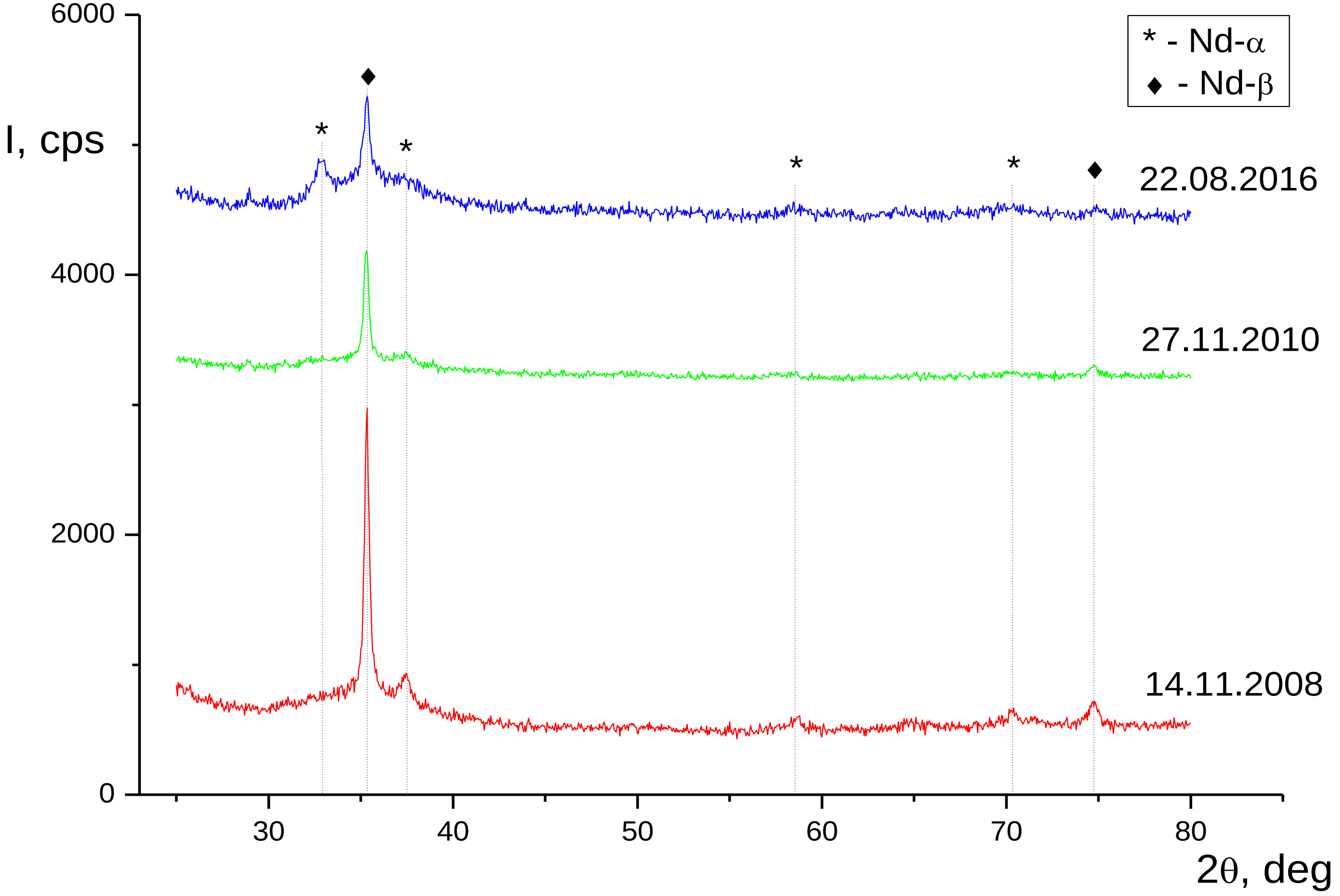
by fast cooling (up to 10^6 K/s)



a **b** **c**

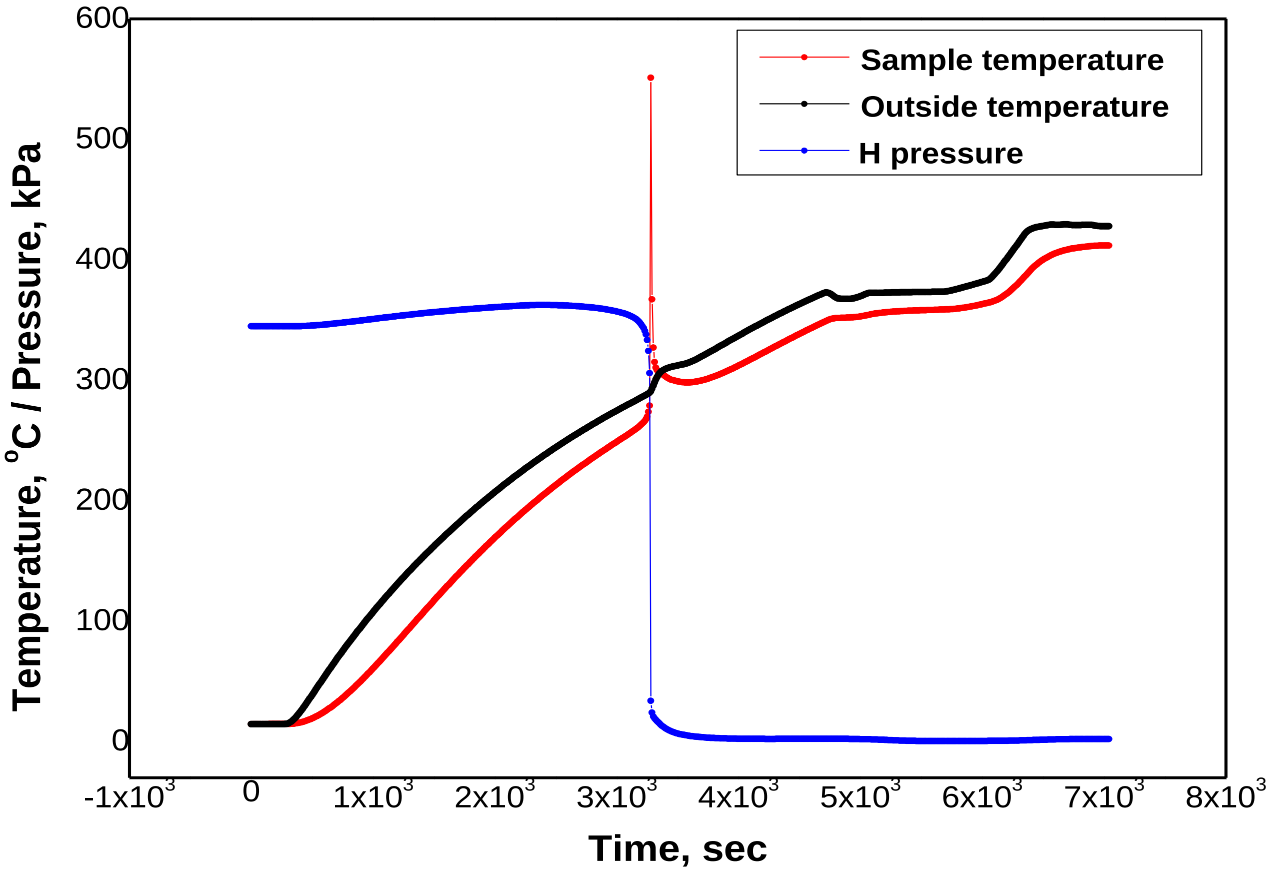
The appearance (a) and surface morphology (b) of the melt spun $Nd_{90}Fe_{10}$ films.
(c) The unite cell of amorphous phase Nd_2Fe_{17} entering the initial microstructure of $Nd_{90}Fe_{10}$.

X ray diffraction study (Igor Kolodij)



Diffractograms of three different films, where the height of the diffraction peak corresponds to the crystalline fraction in a sample X_c = 10% (blue curve); 20% (green curve) and 45% (red curve)

Hydrogenation of $Nd_{10}Fe_{10}$ under DC heating



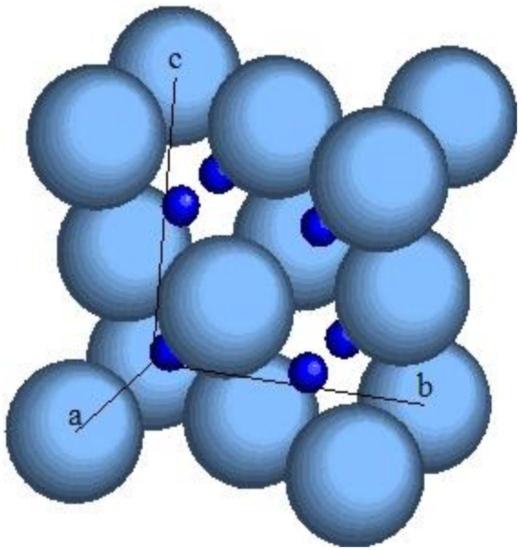
$Nd_{90}Fe_{10}$ films with X_c = 11% of a mass 2.3713 g wrapped in a Cu foil of a mass 1.6225 gram. The loading ratio measured by the H pressure drop after hydrogenation was ~1.6 H per metal atom (~1.36 wt% H). 'Outside temperature' is measured at 2 mm distance from the external ceramic wall of the reactor.

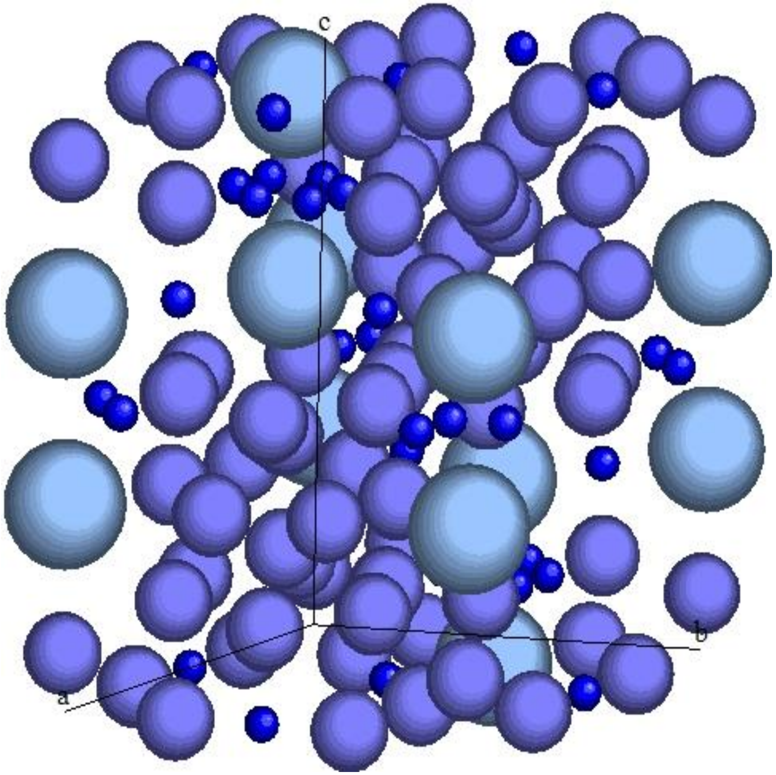
Before the reaction

After the reaction

$Nd_{90}Fe_{10}$ films with X_c = 11% of a mass 2.3713 g wrapped in a Cu foil of a mass 1.6225 gram before and after hydrogenation

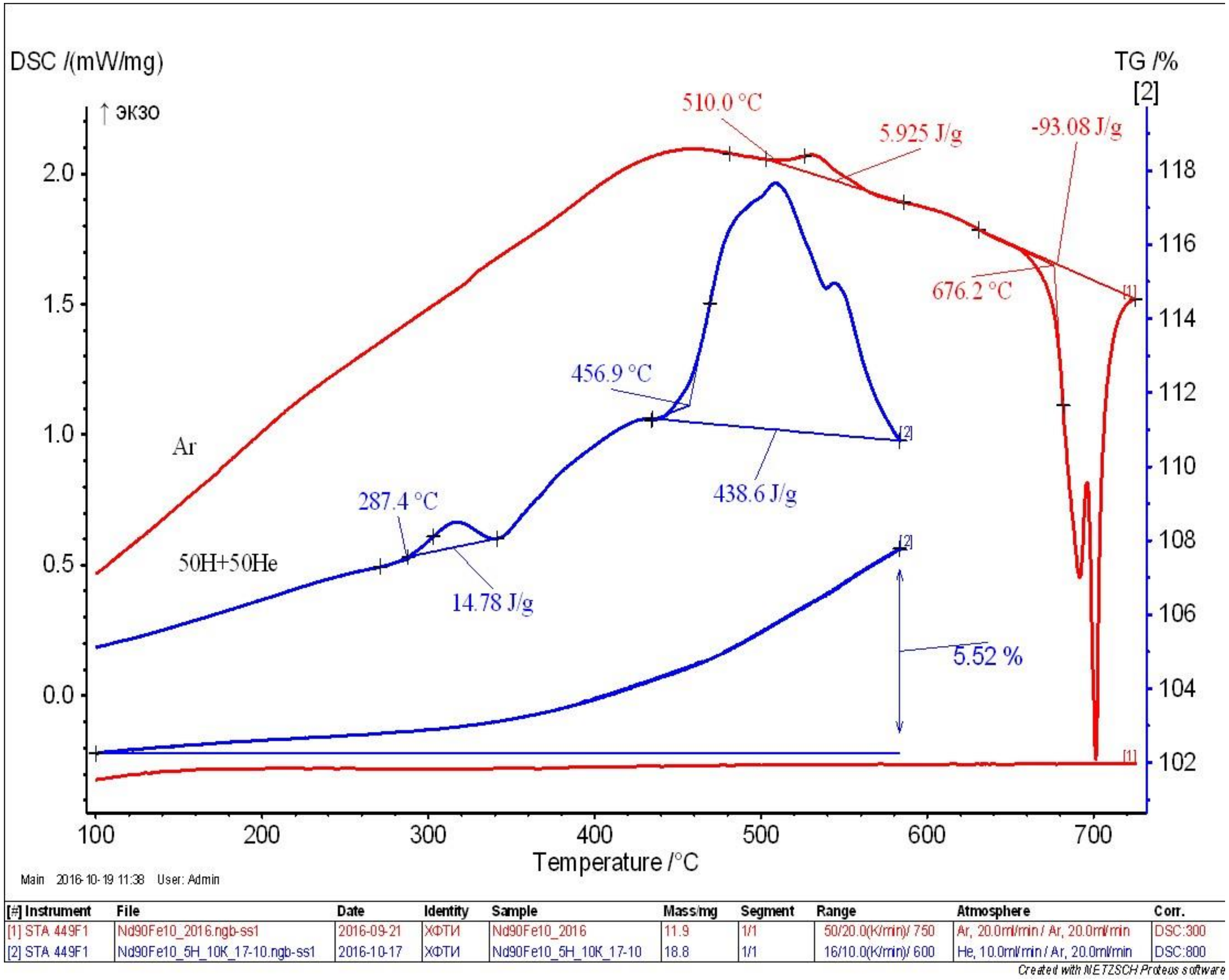
After the reaction





Unite cells of fcc NdH_2 (left) and hcp $Nd_2Fe_{17}H_{4.6}$ (right) phases. NdH_2 is a dominating phase containing a majority of absorbed hydrogen

Differential Scanning Calorimetry (DSC)



DSC of $Nd_{90}Fe_{10}$ samples in the Ar (11.9 mg; heating rate 20 K/min - red curves) and H/He atmosphere (18.8 mg; heating rate 10 K/min - blue curves)

DISCUSSION

The amount of heat produced by the observed reaction (*without account of the heat dissipation*) can be estimated as **2585 J** given by the sum

$$\Delta Q_{tot} = \Delta Q_{NdFe+Cu}\left(830\ \mathrm{K}\right) + \Delta Q_{Al_2O_3}\left(13\ \mathrm{K}\right) = 1263\ \mathrm{J} + 1322\ \mathrm{J} = 2585\ \mathrm{J}$$

Dividing this heat by the amount of absorbed hydrogen that caused the reaction, 0.031 g, one obtains a specific heat of hydrogen absorption as

$$Q_H = 2585\ \mathrm{J}/0.032\ \mathrm{g} = 80170\ \mathrm{J}\ /\ g$$

Specific heat of hydrogen absorption in a DCS experiment is given by **11300 J/g**, which is almost an order of magnitude less than **80170 J/g** estimated in our hydrogenation experiments. It means that the underlying reactions taking place in our experiments should be different from those taking place in a DSC installation.

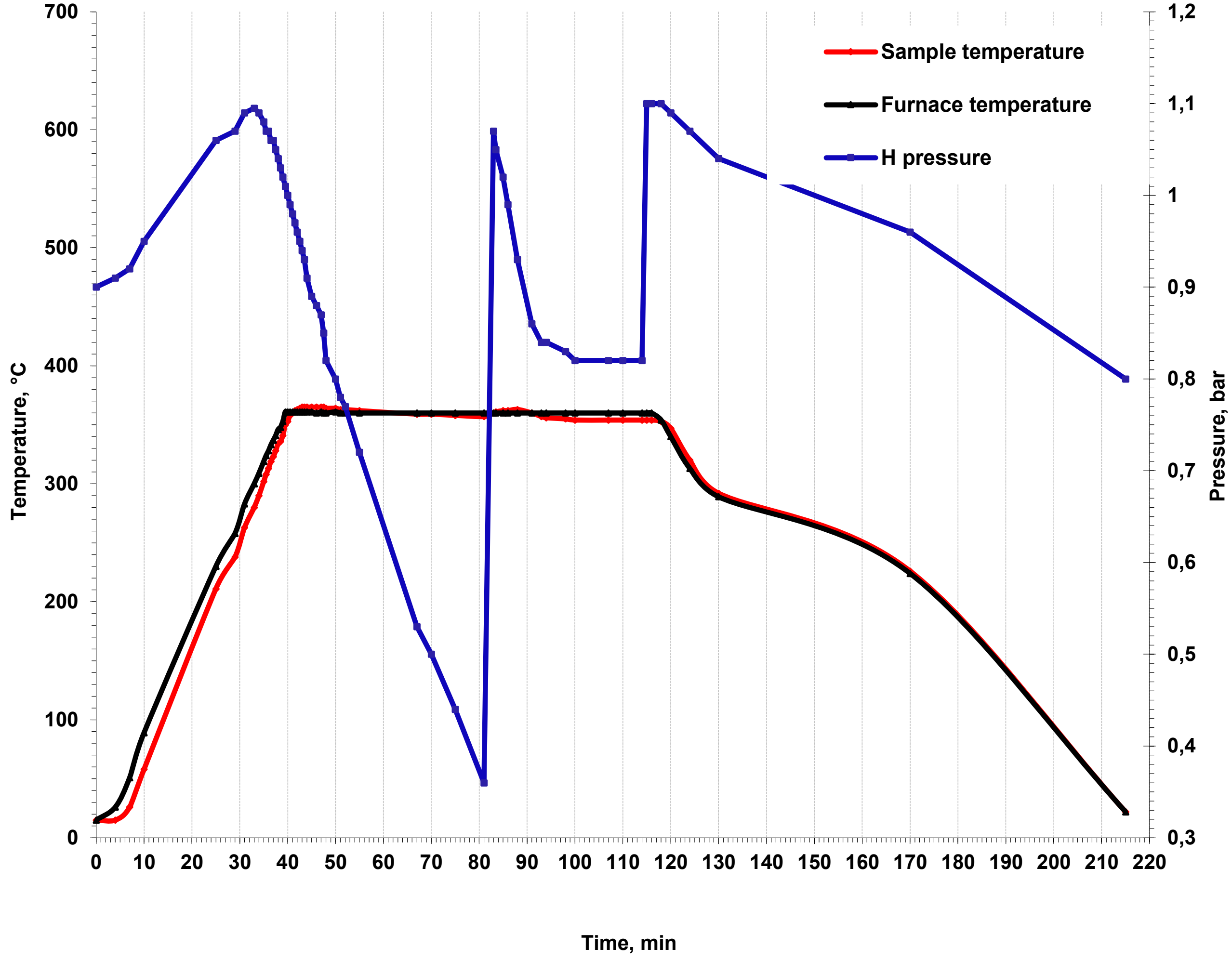
What is happening ?

Hydrogenation of the amorphous $Nd_{90}Fe_{10}$ structure excites LAVs => LAVs catalyze H absorption and LENR => LENR produces heat => heat melts the structure, which kills LAVs and stops LENR => the samples cool down in the form of hydride crystals: NdH_2 (fcc), $Nd_2Fe_{17}H_{4.8}$ (hcp) and $Nd(OH)_3$ (hcp) => shown by X ray analysis

What is to be done ?

To slow down the reaction by regulating H supply or taking away produced heat ?

Deuterium absorption by $Nd_{90}Fe_{10}$ mixed with Cu powder



$Nd_{90}Fe_{10}$ powder with X_c = 11% of a mass 1.7222 g mixed with Cu powder of a mass 2.2526 g, wrapped in a Cu foil of a mass 0.43955 g and packed in a Cu tube of a mass 9.565 g.

CONCLUSIONS on $Nd_{90}Fe_{10}$ experiment:

Quantitative analysis have shown that the amount of heat produced in $Nd_{90}Fe_{10}$ samples in our experiments cannot be explained by DSC data on the heat produced in small samples.

One of the possible explanations of this discrepancy is based LENR taking place *at the initial stage of hydride formation*, when 80÷90% of amorphous phase in the films support the LAV formation, which triggered LENR. Subsequently, the amorphous phase transforms to crystalline hydrides where the LAVs do not form, which stops the LENR. Upon cooling, various hydride phases are observed by X ray analysis: NdH_2 (fcc) and $Nd_2Fe_{17}H_{4.8}$ (hcp).

Conclusions and outlook

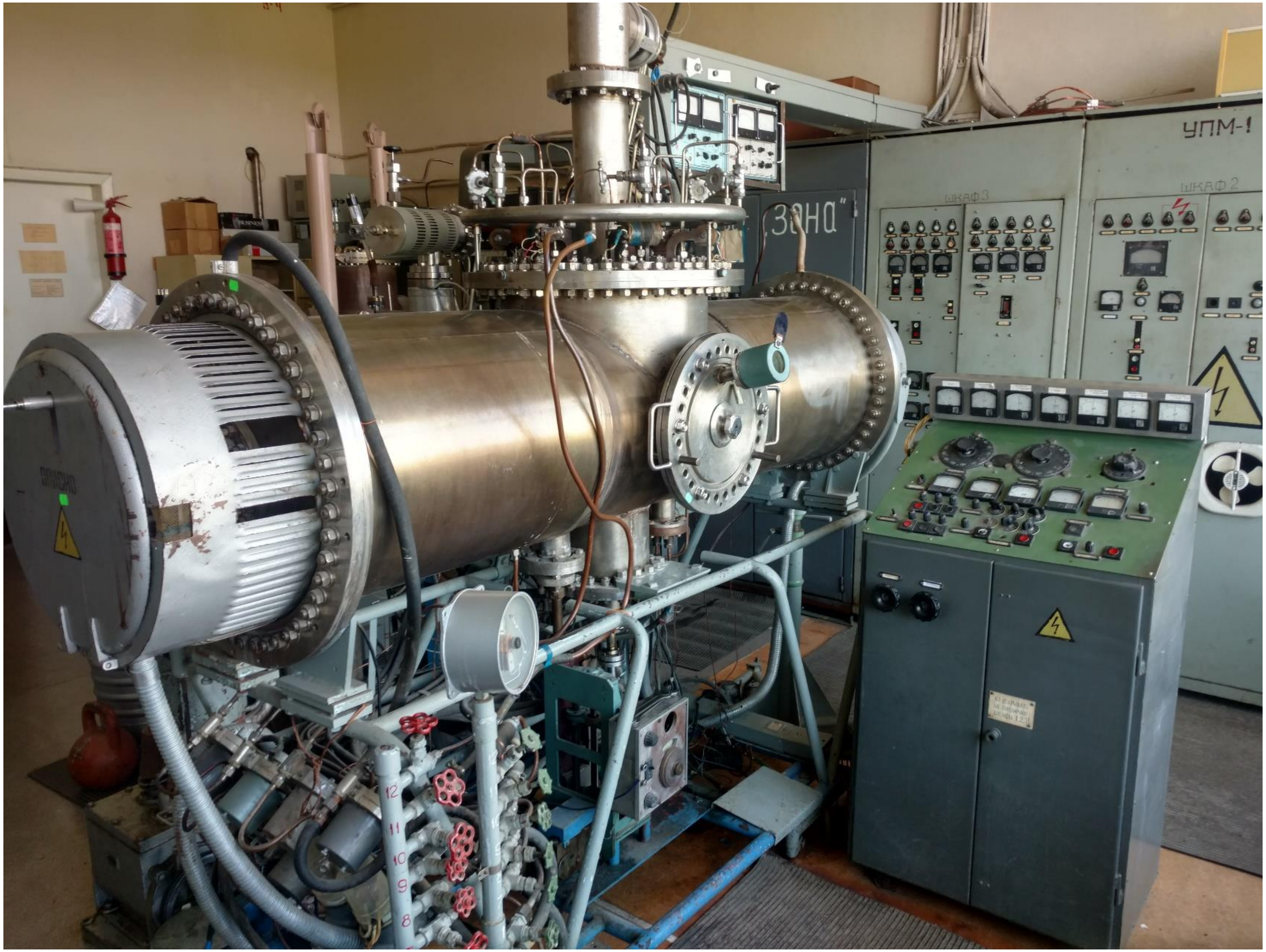
•We presented an experimental setup that allows accurate measuring of the main parameters controlling the reaction: hydrogen pressure, temperature inside the fuel and at the heater, the difference between which can provide direct evidence of the excess heat.

•Our installation combines the **heating** with ***electromagnetic*** and ***radiation-induced*** driving, provides the temperature and gas pressure automatic control, gamma detectors etc.

•First tests of the interaction of Ni with H and $LiAlH_4$ under heating and gamma irradiation revealed important artefacts, which should be taken into account in further experimental setups.

Specially designed new material, based on amorphous $\mathbf{Nd_{90}Fe_{10}}$ composition shows abnormal heat production under hydrogenation, the physical origin of which requires further investigations.

Future plans: Ti-Zr-Ni alloys etc.



High-vacuum electron-beam melting unit for metals **EBM-1**.

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7. V. I. Dubinko, *Radiation-induced catalysis of low energy nuclear reactions in solids***,** **J. Micromechanics and Molecular Physics**, 1 (2016) 165006 -1-12.
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9. V. Dubinko, D. Laptev, K. Irwin*, Catalytic mechanism of LENR in quasicrystals based on localized anharmonic vibrations and phasons, ICCF20,* https://arxiv.org/abs/1609.06625.

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THANK YOU
FOR YOUR ATTENTION!